



THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Masahiro SASAGWA et al.

Serial No.: 10/549,618

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For : POLYMER FOAM CONTAINING A HYDROGENATED COPOLYMER

Art Unit : 1794

Examiner : Victor S. Chang

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DECLARATION

I, Syuji YAHIRO, a Japanese citizen residing at Dormy Oimachi, 4-10-6 Higashi-oi, Shinagawa-ku, Tokyo, Japan, hereby declare and state:

I took a master course majoring in industrial chemistry at Graduate School of Engineering, Kyushu Institute of Technology, Japan, and I was graduated therefrom in March 1989.

I entered Asahi Kasei Kabushiki Kaisha in April 1989. I was engaged in the research and development of synthetic plastics from April 1989 to February 2004. Since February 2004, I have been engaged in the research and development of

synthetic rubbers.

I am a researcher of the Assignee Company and I am well familiar with the present case.

I have read and understood the Office Action dated September 29, 2009 and the references cited therein.

I have instantly conducted two additional experiments (referred to as "Additional Experiment 1" and "Additional Experiment 2", respectively) and have made observations to show, with reference to Additional Experiments 1 and 2 as well as Example 1 of the present application, that, by the use of the hydrogenated copolymer (A) recited in amended claim 1, there can for the first time be obtained a polymer foam which exhibits excellent properties with respect to all of flexibility, low temperature characteristics (such as flexibility at low temperatures), shock-absorbing property (low impact resilience) and compression set resistance. The method and results are as described in a paper attached hereto and marked "Exhibit 1".

From the results of Exhibit 1, it can be fairly concluded:

(1) that the polymer foam of Example 1 exhibits excellent properties with respect to all of flexibility, low tempera-

ture characteristics (such as flexibility at low temperatures), shock-absorbing property (low impact resilience) and compression set resistance, because the polymer foam is produced using polymer 1 encompassed by the hydrogenated copolymer (A) recited in amended claim 1;

(2) that, on the other hand, the polymer foam of Additional Experiment 1 exhibits poor shock-absorbing property, because the polymer foam is produced using polymer  $\alpha$ , which is not encompassed by the hydrogenated copolymer (A) recited in amended claim 1 in that the peak of loss tangent is observed at  $-42^{\circ}\text{C}$ , which is lower than the lower limit ( $-40^{\circ}\text{C}$ ) of the presently claimed range;

(3) that, further, the polymer foam of Additional Experiment 2 exhibits poor low temperature characteristics (such as flexibility at low temperatures), because the polymer foam is produced using polymer  $\beta$ , which is not encompassed by the hydrogenated copolymer (A) recited in amended claim 1 in that the peak of loss tangent is observed at  $12^{\circ}\text{C}$ , which is higher than the upper limit ( $-10^{\circ}\text{C}$ ) of the presently claimed range; and

(4) that, therefore, by the use of the hydrogenated copolymer (A) recited in amended claim 1, there can for the first time be obtained a polymer foam which exhibits excellent

properties with respect to all of flexibility, low temperature characteristics (such as flexibility at low temperatures), shock-absorbing property (low impact resilience) and compression set resistance.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

December 25, 2009

Date

Syuji Yahiro

Syuji YAHIRO

Observations to show that, by the use of the hydrogenated copolymer (A) recited in amended claim 1, there can for the first time be obtained a polymer foam which exhibits excellent properties with respect to all of flexibility, low temperature characteristics (such as flexibility at low temperatures), shock-absorbing property (low impact resilience) and compression set resistance

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**1. Object of observations**

The object of the observations is to show, with reference to the below-mentioned two additional experiments as well as Example 1 of the present application, that, by the use of the hydrogenated copolymer (A) recited in amended claim 1, there can for the first time be obtained a polymer foam which exhibits excellent properties with respect to all of flexibility, low temperature characteristics (such as flexibility at low temperatures), shock-absorbing property (low impact resilience) and compression set resistance.

**2. Two additional experiments**

Two additional experiments (hereinafter referred to as "Additional Experiment 1" and "Additional Experiment 2", respectively) were instantly conducted as follows.

#### Additional Experiment 1

An unhydrogenated copolymer was obtained in substantially the same manner as in the production of polymer 1 described at page 89, line 2 to page 91, line 21 of the present specification, except that the amounts of monomers (i.e., butadiene and styrene) fed to the reaction vessel were changed as follows: the amount of styrene fed to the reaction vessel for the first polymerization reaction was 24 parts by weight; the amounts of butadiene and styrene, fed to the reaction vessel for the second polymerization reaction, were 48 parts by weight and 5 parts by weight, respectively; and the amount of styrene fed to the reaction vessel for the third polymerization reaction was 23 parts by weight.

The obtained unhydrogenated copolymer had a styrene monomer unit content of 52 % by weight, a styrene polymer block content of 47 % by weight, and a vinyl bond content of 20 % by weight as measured with respect to the butadiene monomer units in the unhydrogenated copolymer. Further, the unhydrogenated copolymer had a weight average molecular weight of 130,000.

A hydrogenation reaction was performed in substantially the same manner as in the production of polymer 1, thereby obtaining a hydrogenated copolymer (hereinafter, this copoly-

mer is referred to as "polymer  $\alpha$ ").

Polymer  $\alpha$  had a hydrogenation ratio of 98 %. Further, in a dynamic viscoelastic spectrum obtained with respect to polymer  $\alpha$ , a peak of  $\tan\delta$  was observed at -42 °C.

A polymer foam was produced in substantially the same manner as in Example 1 of the present application (see page 98, line 10 to page 99, line 22 of the present specification), except that polymer  $\alpha$  was used instead of polymer 1. Thus, the polymer foam contained 70 part by weight of polymer  $\alpha$  and 30 parts by weight of rubbery polymer 1 described at page 95, line 9 to page 98, line 8 of the present specification.

Properties of the polymer foam were measured in accordance with the methods described in the present specification (see page 84, line 19 to page 87, line 18 of the present specification). The results are as follows:

Specific gravity: 0.23

Hardness at 22 °C: 50

Hardness at -10 °C: 49

Impact resilience (%): 46

Compression set (%): 43

#### Additional Experiment 2

An unhydrogenated copolymer was obtained in substan-

tially the same manner as in the production of polymer 1 described at page 89, line 2 to page 91, line 21 of the present specification, except that the amounts of monomers (i.e., butadiene and styrene) fed to the reaction vessel were changed as follows: the amount of styrene fed to the reaction vessel for the first polymerization reaction was 6 parts by weight; the amounts of butadiene and styrene, fed to the reaction vessel for the second polymerization reaction, were 41 parts by weight and 47 parts by weight, respectively; and the amount of styrene fed to the reaction vessel for the third polymerization reaction was 6 parts by weight.

The obtained unhydrogenated copolymer had a styrene monomer unit content of 59 % by weight, a styrene polymer block content of 12 % by weight, and a vinyl bond content of 19 % by weight as measured with respect to the butadiene monomer units in the unhydrogenated copolymer. Further, the unhydrogenated copolymer had a weight average molecular weight of 160,000.

A hydrogenation reaction was performed in substantially the same manner as in the production of polymer 1, thereby obtaining a hydrogenated copolymer (hereinafter, this copolymer is referred to as "polymer  $\beta$ ").

Polymer 2 had a hydrogenation ratio of 99 %. Further, in



a dynamic viscoelastic spectrum obtained with respect to polymer  $\beta$ , a peak of  $\tan\delta$  was observed at 12 °C.

A polymer foam was produced in substantially the same manner as in Example 1 of the present application (see page 98, line 10 to page 99, line 22 of the present specification), except that polymer  $\beta$  was used instead of polymer 1. Thus, the polymer foam contained 70 part by weight of polymer  $\beta$  and 30 parts by weight of rubbery polymer 1 described at page 95, line 9 to page 98, line 8 of the present specification.

Properties of the polymer foam were measured in accordance with the methods described in the present specification (see page 84, line 19 to page 87, line 18 of the present specification). The results are as follows:

Specific gravity: 0.23

Hardness at 22 °C: 45

Hardness at -10 °C: 70

Impact resilience (%): 5

Compression set (%): 55

### 3. Observations

In Example 1 of the present application and above-conducted Additional Experiments 1 and 2, polymer foams containing hydrogenated copolymers are produced, and properties

of the polymer foams are measured (see page 98, line 10 to page 99, line 22 of the present specification and above-described Additional Experiments 1 and 2). In Example 1, Additional Experiment 1 and Additional Experiment 2, polymers 1,  $\alpha$  and  $\beta$  are respectively used as the hydrogenated copolymer.

The characteristics of polymer 1 are described at page 89, line 2 to page 91, line 21 of the present specification. Polymer 1 is a hydrogenated copolymer which is obtained by hydrogenating an unhydrogenated block copolymer having a block configuration H-S-H, wherein each H independently represents a styrene polymer block and S represents a styrene/butadiene copolymer block (see page 89, line 3 to page 91, line 14 of the present specification). The copolymer block S has a vinyl bond content of 20 % as measured with respect to butadiene monomer units (see page 90, lines 18-21 of the present specification). Also, polymer 1 has a styrene monomer unit (vinyl aromatic monomer unit) content of 52 % by weight (see page 90, lines 16-17 of the present specification). (It should be noted that, as described at page 20, lines 2-9 of the present specification, the content of the vinyl aromatic monomer units in the hydrogenated copolymer is approximately equal to the content of the vinyl aromatic monomer units in the unhydrogenated copolymer and, therefore,

the content of the vinyl aromatic monomer units in the unhydrogenated copolymer can be used as the content of the vinyl aromatic monomer units in the hydrogenated copolymer.) Further, in a dynamic viscoelastic spectrum obtained with respect to polymer 1, a peak of loss tangent ( $\tan\delta$ ) is observed at  $-15^{\circ}\text{C}$  (see page 91, lines 16-18 of the present specification).

Based on the information on the characteristics of polymer 1, and the information on the characteristics of polymers  $\alpha$  and  $\beta$  described in Additional Experiments 1 and 2, the following Table A is obtained:

Table A

	Polymer 1	Polymer $\alpha$	Polymer $\beta$
Block configuration	H-S-H	H-S-H	H-S-H
Vinyl bond content (%)	20	20	19
Styrene content (%) of the hydrogenated copolymer	52	52	59
Peak ( $^{\circ}\text{C}$ ) of loss tangent ( $\tan\delta$ )	-15	-42	12

Notes:

(1) "Block configuration" means the block configuration of the unhydrogenated block copolymer from which the hydrogenated copolymer is produced by hydrogenation. In these block configurations, each H independently represents a styrene polymer block and each S independently represents a styrene/butadiene copolymer block.

(2) "Vinyl bond content" means the vinyl bond content of the copolymer block S (as measured with respect to butadiene monomer units) contained in the unhydrogenated block copolymer.

Properties of the polymer foam produced in Example 1 are shown in Table 1 appearing at page 104 of the present specification. Based on the information on the properties of the polymer foam produced in Example 1, and the information on the properties of the polymer foams produced in Additional Experiments 1 and 2, the following Table B is obtained:

Table B

	Example 1 (in which polymer 1 is used)	Additional Ex- periment 1 (in which polymer $\alpha$ is used)	Additional Ex- periment 2 (in which polymer $\beta$ is used)
Specific gravity	0.23	0.23	0.23
Hardness at 22 °C	40	50	45
Hardness at -10 °C	50	49	70
Impact resilience (%)	29	46	5
Compression set (%)	44	43	55

Notes:

- (1) The smaller the hardness of the polymer foam at 22 °C, the better the flexibility of the polymer foam (see page 85, lines 6-7 of the present specification).
- (2) The smaller the hardness of the polymer foam at -10 °C, the better the low temperature characteristics of the polymer foam (see page 85, lines 8-10 of the present specification).
- (3) The smaller the impact resilience of the polymer foam, the better the shock-absorbing property of the polymer foam (see page 87, lines 16-18 of the present specification).
- (4) The smaller the compression set of the polymer foam, the better the compression set resistance of the polymer foam (see page 86, lines 18-20 of the present specification).

Observations are made below with reference to Tables A and B above.

At the outset, it should be noted that, among polymers 1,  $\alpha$  and  $\beta$ , polymer 1 is encompassed by the hydrogenated copolymer (A) recited in amended claim 1, whereas polymers  $\alpha$  and  $\beta$  are not encompassed by the hydrogenated copolymer (A) recited in amended claim 1. On this point, explanation is given below.

The hydrogenated copolymer (A) recited in amended claim 1 is obtained by hydrogenating an unhydrogenated copolymer. The hydrogenated copolymer (A) has the following features (I) to (IV):

(I) The unhydrogenated copolymer from which the hydrogenated copolymer (A) is obtained by hydrogenation is a block copolymer containing at least one copolymer block S comprised of vinyl aromatic monomer units and conjugated diene monomer units and at least one homopolymer block H of vinyl aromatic monomer units, and has a specific block configuration, such as "H-S-H".

(II) The at least one copolymer block S has a vinyl bond content of from 5 % to less than 40 % as measured with re-

spect to conjugated diene monomer units.

(III) The hydrogenated copolymer (A) has a content of the vinyl aromatic monomer units of from more than 40 % by weight to 60 % by weight, based on the weight of the hydrogenated copolymer (A).

(IV) At least one peak of loss tangent ( $\tan\delta$ ) is observed at -40 °C to lower than -10 °C in a dynamic viscoelastic spectrum obtained with respect to the hydrogenated copolymer (A).

As seen from Table A above, polymer 1 has all of features (I) to (IV). On the other hand, polymer  $\alpha$  has features (I) to (III), but does not have feature (IV); in polymer  $\alpha$ , the peak of loss tangent is observed at -42 °C, which is lower than the lower limit (-40 °C) of the range defined in feature (IV). Further, polymer  $\beta$  has features (I) to (III), but does not have feature (IV); in polymer  $\beta$ , the peak of loss tangent is observed at 12 °C, which is higher than the upper limit (-10 °C) of the range defined in feature (IV).

As explained above, the polymer foams in Additional Experiments 1 and 2 are produced in substantially the same manner as in the production of the polymer foam in Example 1,

except that, polymers  $\alpha$  and  $\beta$  are respectively used as the hydrogenated copolymer in place of polymer 1. Therefore, the differences in properties between the polymer foams produced in Example 1 and Additional Experiments 1 and 2 are caused due to the differences in characteristics between the hydrogenated copolymers used in Example 1 and Additional Experiments 1 and 2.

As seen from Table B above, the polymer foam of Example 1 exhibits excellent properties with respect to all of flexibility, low temperature characteristics (such as flexibility at low temperatures), shock-absorbing property (low impact resilience) and compression set resistance. The excellent properties of the polymer foam of Example 1 is achieved by the use of polymer 1 (which is encompassed by the hydrogenated copolymer (A) recited in amended claim 1) for producing the polymer foam.

On the other hand, the polymer foam of Additional Experiment 1 exhibits excellent properties with respect to flexibility, low temperature characteristics (such as flexibility at low temperatures) and compression set resistance, but exhibits poor shock-absorbing property as compared to the case of the polymer foam of Example 1. Specifically, the polymer foam of Additional Experiment 1 exhibits an impact

resilience of 46 %, which is much higher than the impact resilience of 29 % in the case of the polymer foam of Example 1. The poor property of the polymer foam of Additional Experiment 1 is caused due to the use of polymer  $\alpha$  for producing the polymer foam. Polymer  $\alpha$  is not encompassed by the hydrogenated copolymer (A) recited in amended claim 1 in that the peak of loss tangent is observed at -42 °C, which is lower than the lower limit (-40 °C) of the presently claimed range.

Further, the polymer foam of Additional Experiment 2 exhibits excellent properties with respect to flexibility, shock-absorbing property (low impact resilience) and compression set resistance, but exhibits poor low temperature characteristics (such as flexibility at low temperatures) as compared to the case of the polymer foam of Example 1. Specifically, the polymer foam of Additional Experiment 2 exhibits a hardness of 70 at -10 °C, which is much higher than the hardness of 50 at -10 °C in the case of the polymer foam of Example 1. The poor property of the polymer foam of Additional Experiment 2 is caused due to the use of polymer  $\beta$  for producing the polymer foam. Polymer  $\beta$  is not encompassed by the hydrogenated copolymer (A) recited in amended claim 1 in that the peak of loss tangent is observed at 12 °C, which is higher than the upper limit (-10 °C) of the presently claimed



range.

#### 4. Conclusion

From the observations, it can be fairly concluded:

(1) that the polymer foam of Example 1 exhibits excellent properties with respect to all of flexibility, low temperature characteristics (such as flexibility at low temperatures), shock-absorbing property (low impact resilience) and compression set resistance, because the polymer foam is produced using polymer 1 encompassed by the hydrogenated copolymer (A) recited in amended claim 1;

(2) that, on the other hand, the polymer foam of Additional Experiment 1 exhibits poor shock-absorbing property, because the polymer foam is produced using polymer  $\alpha$ , which is not encompassed by the hydrogenated copolymer (A) recited in amended claim 1 in that the peak of loss tangent is observed at  $-42^{\circ}\text{C}$ , which is lower than the lower limit ( $-40^{\circ}\text{C}$ ) of the presently claimed range;

(3) that, further, the polymer foam of Additional Experiment 2 exhibits poor low temperature characteristics (such as flexibility at low temperatures), because the polymer foam is produced using polymer  $\beta$ , which is not encompassed by the hy-

drogenated copolymer (A) recited in amended claim 1 in that the peak of loss tangent is observed at 12 °C, which is higher than the upper limit (-10 °C) of the presently claimed range; and

(4) that, therefore, by the use of the hydrogenated copolymer (A) recited in amended claim 1, there can for the first time be obtained a polymer foam which exhibits excellent properties with respect to all of flexibility, low temperature characteristics (such as flexibility at low temperatures), shock-absorbing property (low impact resilience) and compression set resistance.